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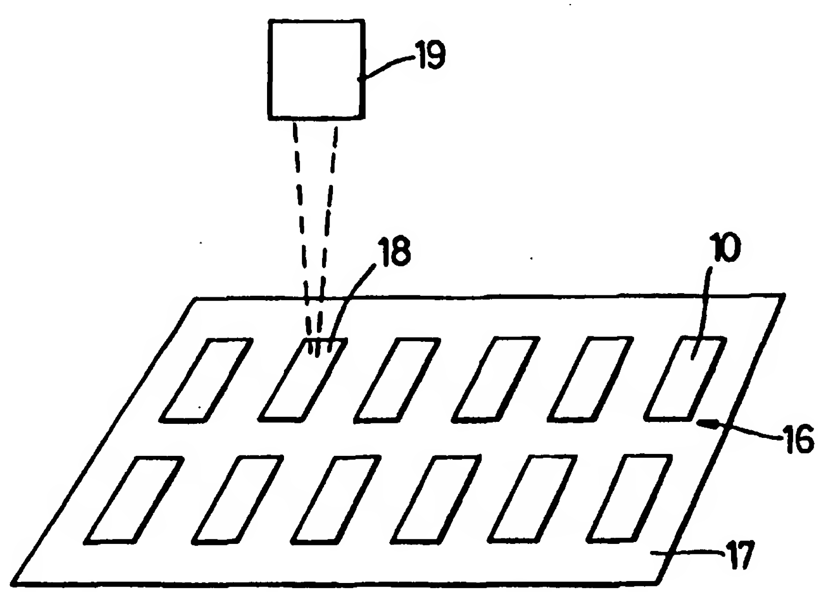
(54) Title: A METHOD OF ETCH DEPTH CONTROL IN SINTERED WORKPIECES

(57) Abstract

This invention relates to etch depth control in sintered workpieces. A batch (16) of heads (10) is mounted on a carrier tray (17) and includes a control head (18), which is made of a single material which etches at a rate which is proportional to or is identical to the etch rate of the sintered materials of the head (10). The depth of etch in the control is monitored by a reflectance interferometer (19).



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A Method of Etch Depth Control in Sintered Workpieces

This invention relates to a method of etching formations in sintered workpieces.

There are many products which are made of sintered materials and large scale formations are formed on them by casting and/or subsequent machining. One example is the etched aerodynamic patterning performed on Read/Write heads for use with hard disk drives and the like. Recently the accuracy of certain features on these heads have had to increase because of the drive towards higher areal densities demands even smaller spacing between the head and the disk (this saving is sometimes referred to as the fly height). Manufacturers have therefore turned to dry etching techniques, such as are used for semiconductor wafers, (in favour of mechanical grinding, etc.) but a problem has arisen with the control of the etching process. The etched depth must be accurately controlled to prevent fly height (and hence head performance) variations. It is common practice to etch the rows of heads or head bars (in a batch) to a depth less than required, then return the batch after etch depth (rate) confirmation, to complete the etch. This presents a problem in volume production where the throughput becomes critical. One solution would be to accurately measure the etch depth in-situ and hence terminate the etch at the desired etch depth. This would completely remove batch to batch target depth control variations and enhance throughput as well as process yield.

In semiconductor etching, it is normal to monitor the depth of a trench or other formations by shining a laser beam onto the bottom of the trench or formation and detecting the relative reflections from the bottom of the trench and the photoresist masked surface which protects the layer which is being etched. However, for sintered materials there is significant roughness at the bottom of the trench due to the unevenness of the etch rate of the constituent materials. This results in sufficient scattering of the light to inhibit an interferometric signal. Minimising the roughness by matching the etch rates of the primary compounds can improve the reflected signal directionally. However the differential rates cannot be sufficiently matched in all cases without prejudicing other desired etch parameters such as etch rate, mask, selectivity and sidewall signal, etc. Also it is common for the sintered material to contain other additional elements (eg. Al_2O_3/TiC can contain Y, Mg, Ca, etc) which can often result in extreme difficulty in maintaining a low surface roughness. In the present investigation a large number of attempts to convert existing equipment have failed. In one experiment the interferometric signal relating to the etching rate of the photoresist was successfully maintained. However, the repeatability in etch selectivity between the sintered material and the photoresist was not sufficient to enable the use of photoresist etch rate being the control parameter, particularly as the resist is highly sensitive to chemical concentration changes in contrast to the sintered materials.

It has therefore proved extremely difficult to control the treatment of a single batch of heads, let alone to establish good conformity between batches.

From one aspect the invention consists in a method of etching formations in sintered workpieces comprising, loading a batch of workpieces having a photoresist layer deposited thereon into an etching chamber together with a control workpiece, etching the workpieces, through the openings in the layer, and the control, monitoring the etch depth on the control and stopping the etch process when the etch depth on the control is the requisite depth.

In a preferred embodiment, the control is made of one of the sintered components or other (non cross contaminating) material which has an etch rate equivalent to or proportional to that of the sintered material. In this case the requisite depth may be the required depth of the formation. For example when etching Al_2O_3/TiC the control may be made of Al_2O_3,TiC,SiC,SiO_2,TiO_2,Si,Al,AlSi or Ti. Mask materials (eg. organic polymer such as photo resist; polyamide etc, could be used. Where the material is transparent at the wavelength of the light used, a backside metallisation layer can be used to allow the inferometry to be used. In this case the control cleaning does not need to be masked as described below.

It is preferred that the requisite depth is monitored using a reflectance interferometer.

As has already been mentioned the method is particularly suitable for use for head bars for Read/Write heads, but

many other sintered objects can be similarly treated.

Conveniently, the control workpiece will pass through all the treatment steps with a batch prior to the etching step, e.g. the deposition of the photoresist mask. However, specially prepared control workpieces could be used and inserted only at the etch stage eg. transparent control workpieces. The mask may be formed in a variety of ways and may include photoresist spin on glasses, polyamides, etc.

Although the invention has been defined above it is to be understood that it includes any inventive combination of the features set out above or in the following description.

The invention may be performed in various ways and a specific embodiment will now be described, with reference to the accompanying drawings in which:

Figure 1 illustrates a typical thin film head for a Read/Write device;

Figure 2 shows an enlarged view of one side of the formation during etching, and

Figure 3 schematically illustrates a batch of heads bonded to a carrier with a reflectance interferometer and monitoring the control head.

As can be seen in Figure 1, a Read/Write head, generally indicated at 10 has a channel 11 etched out of it, which defines the relative distances between the pole tips of the magnetic head 12 and the air bearing surface 13. The base 14 of the channel is illustrated in the enlarged view A and it will be noted that, due to the uneven etch of the component material, the base 14 is substantially rough.

Turning to Figure 2 it will be seen that prior to etching the head 10 has a photoresist mask 15 deposited on it and the etching takes place through openings on the mask as is conventional.

In accordance with the method of the invention, a batch 16 of heads 10 is mounted on a carrier tray 17 and includes a control head 18, which is made of a single material which etches at a rate which is proportional to or is identical to the etch rate of the sintered materials of the heads 10. The control may be one of the sintered components or some other suitable material. The depth of etch in the control head 18 is monitored by reflectance interferometer 19 and because the control material is carefully selected, the etch process can be controlled in accordance with the output of that device.

The control head 18 may carry a mask corresponding to mask 15 which may etch at the same rate as mask 15. Alternatively if the mask is transparent to the interferometer radiation, it may simply be sufficiently robust to out last the etch. In a still further arrangement, if the control head is transparent at the wavelength of radiation of the interferometer, the control head may have a backside metallisation layer, so that light is reflected from that layer to provide a datum. In that case, at least, the control does not require a photo resist layer.

Thus, by providing the control in the batch, automatic production is easily facilitated. In contrast, currently, manufacturers regularly stop the etch process and unload the

batches so that the etch depth can be physically measured.

Claims

1. A method of etching formations in sintered workpieces comprising loading a batch of workpieces a photoresist layer deposited thereon in an etching chamber together with a control workpiece, etching the workpieces, through openings in the layer, and the control, monitoring the etch depth on the control and stopping the etch process when the etch depth on the control is the requisite depth.

2. A method as claimed in claim 1 wherein the control is made of one of the sintered components or other non-cross contaminating material which has an etch rate equivalent to or proportional to that of the sintered material.

3. A method as claimed in claim 2 wherein the workpieces are made of Al_2O_3/TiC and the control is made of Al_2O_3, TiC, SiC, SiO_2, TiO_2, Si, Al, AlSi, Ti or of photoresist mask material.

4. A method as claimed in any one of claims 1 to 3 wherein the requisite depth is the required depth of the formation.

5. A method as claimed in any one of the preceding claims wherein the requisite depth is monitored using a reflectance interferometer.

6. A method as claimed in claim 5 wherein the control material is transparent to the interferometer radiation and has a reflectance coating on its bottom face.

7. A method as claimed in claim 5 wherein the control workpiece offers a photoresist mask or layer corresponding

to the workpiece mask.

8. A method as claimed in any one of the preceding claims wherein the workpieces are head bars for read/write heads.

9. A method as claimed in any one of the preceding claims wherein the mask is an organic polymeric material or spin-on-glass.

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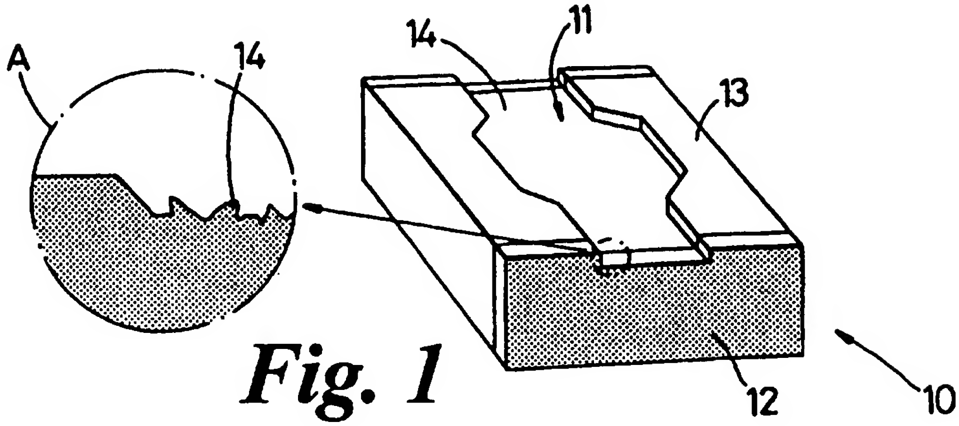


Fig. 1

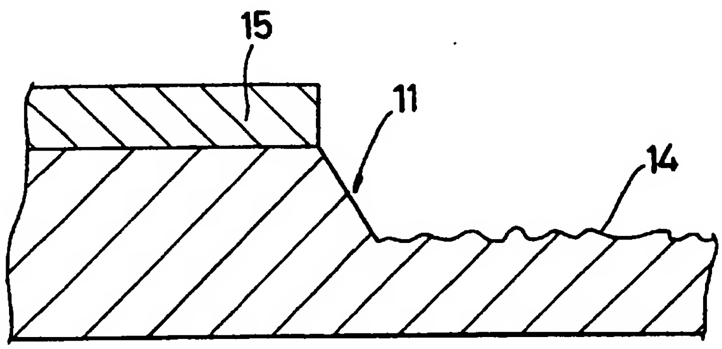
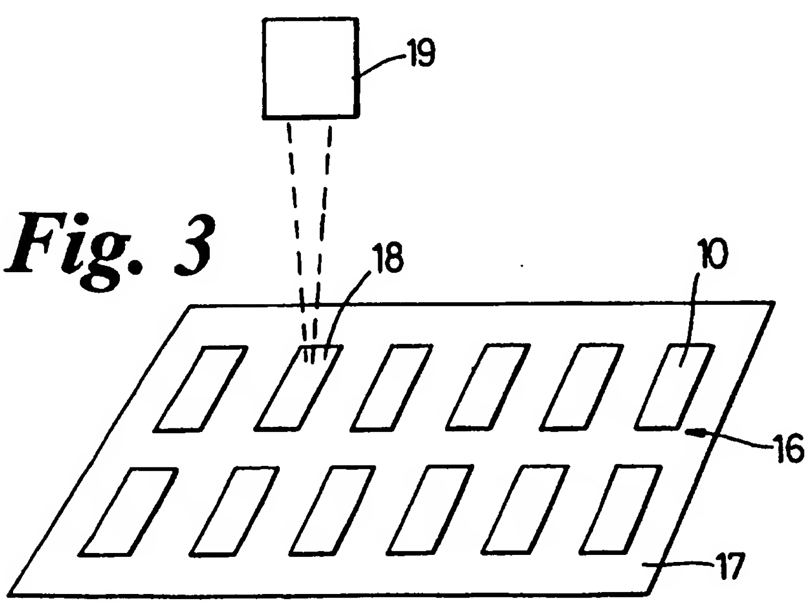


Fig. 2

Fig. 3



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C04B41/91 G11B21/21 H01J37/32

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 4 367 044 A (BOOTH JR ROBERT M ET AL) 4 January 1983 see claims 12,18 see column 1, line 9 - line 15 see column 5, line 1 - line 2 ---	1,2,4-6 7,8
X A	US 4 435 898 A (GAUR SANTOSH P ET AL) 13 March 1984 see claims 1,3,4 ---	1,2,4,5 7
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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X	PATENT ABSTRACTS OF JAPAN vol. 015, no. 459 (E-1136), 21 November 1991 & JP 03 196521 A (NEC KANSAI LTD), 28 August 1991,	1,2,4
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Y	"SMOOTHING THE SURFACE OF MULTI-PHASE MATERIALS" IBM TECHNICAL DISCLOSURE BULLETIN, vol. 31, no. 11, 1 April 1989, page 215 XP000104821	8
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